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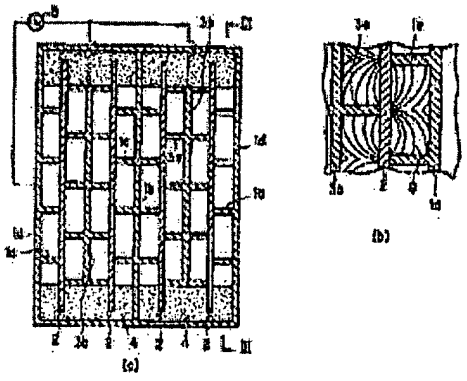
(54) ELECTRIC FIELD APPARATUS FOR GAS OXIDATION

(57)Abstract:
PURPOSE: To provide an electric field apparatus for gas oxidation which can generate a uniform plasma regardless of properties of a gas to be treated.
CONSTITUTION: By arranging projections 1a and 3a and 1c and 3a of electrodes with the same shape in such a way that they are shifted and not neighbor with each other e.g. on the right side and the left side of a dielectric 2, creeping discharge is generated on the face of the opposite side to the face where the dielectric 2 is brought into contact with the projections 1a, 1c and 3a, namely, the surface of the dielectric with which the electrode is not brought into contact. At the same time, as electrodes 1a, 1d, 1b, 1c, 3a and 3b are arranged to the creeping discharge generating face and an electric voltage being the same polarity as that of the creeping discharge generating face is applied, a space between the creeping discharge generating face and the electrodes arranged so as to surround it, namely, the inside of a cylindrical gas flow path is turned to a glow discharge plasma condition.



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CLAIMS

[Claim(s)]
[Claim 1]The 1st electrode that has two or more steps of ledged projections up and down toward an inside from right and left sidewalls of an rectangular pipe-like outer frame, A 1st ctenidium-like electrode which has a ledged projection of the 1st electrode of the above, and two or more steps of ledged projections corresponding to both sides from a septum which divides an inside of the above-mentioned outer frame into right-and-left plurality, A 2nd ctenidium-like electrode which is in a position which shifted from a ledged projection of the 1st electrode of the above, and each 1st ctenidium-like electrode to both sides of a flat wall alternately, and has two or more steps of ledged projections, It has a dielectric which contacts each ledged projection with the 1st electrode of the above, and a 2nd ctenidium-like electrode, is located between them, and contacts each ledged projection with the above-mentioned 1st ctenidium-like electrode and a 2nd ctenidium-like electrode, and is located between them, An electric field device for gas oxidation which impressed different polar voltage between the 1st electrode of the above and a 1st ctenidium-like electrode, and a 2nd ctenidium-like electrode.
[Claim 2]The 1st electrode that has two or more radiate projections toward an internal center from an inner circle wall of a cylindrical outer frame, The 1st cylindrical dielectric in which a peripheral wall contacts an inside of a tip of a radiate projection of this 1st electrode, Take equally circle distance during a radiate projection with which it is inside this 1st dielectric, and it is cylindrical and has a radiate projection in both a peripheral wall and an inner circle wall and which the peripheral-wall side adjoins, and. One step or two or more steps of 2nd electrode that takes equally circle distance during a radiate projection with which a radiate projection by the side of the above-mentioned peripheral wall and a radiate projection of an electrode of the outside are made into physical relationship alternately shifted, and which the inner circle wall side adjoins and to which a radiate projection tip of the above-mentioned peripheral wall contacts an inner circle wall of a cylindrical dielectric further, The 2nd cylindrical dielectric in which a peripheral wall contacts a radiate projection of an inner circle wall of this 2nd electrode, It has the 3rd electrode that keeps circle distance of a radiate projection which a tip of a radiate projection contacts an inner circle wall of the 2nd dielectric of the above, puts together all end faces of this radiate projection, and adjoins each other from physical relationship which moreover shifted alternately this radiate projection and a radiate projection of an inner circle wall of the 2nd electrode of the above equally, An electrode for gas oxidation it was made to impress different polarity to an electrode which adjoins each other on both sides of the above-mentioned dielectric.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the electric field device for gas oxidation applied to the flue gas treatment apparatus etc. which oxidize O_2, manufacture O_3, oxidize the device which makes deodorization and a combustor efficiency improvement or NO_x, and SO_x, and perform denitrification and desulfurization.
[0002]
[Description of the Prior Art]Drawing 7 and drawing 8 are the explanatory views of the electric field device for gas oxidation used from the former. It explains taking the case of the case where NO_x in the exhaust gas of for example, a gas **** boiler is processed with this device. In drawing 7, 101 is a reaction vessel of the conventional electric field device for gas oxidation, and the passage which has a square section adjoins a flight, and is allocated, and it forms the honeycomb structured body which consists of insulating Ceramics Sub-Division, such as alumina ceramics, silicon nitride porcelain, and zirconia ceramics. If one tubular passage of this honeycomb structured body is explained, this is constituted by four continuous walls of 102,103,104,105, and if it develops, it will become like drawing 8. The wall 102,103,104,105 makes the structure bent by 90 degrees according to the boundary line 106,107,108,109. The corona discharge pole 113,114 which follows the end 110 of the wall 102 with the terminal 111,112 which stands in a row to the power supply 127, and consists of conducting films, such as tungsten, is mutually continued and installed in the surface of the wall 102,103,104,105 regular intervals and in parallel.
[0003]If the pulse high voltage whose pulse width is 1 ns - about 1000 ns is impressed among the above-mentioned corona discharge poles 113 and 114, introducing the exhaust gas of a gas **** boiler into the inside of the reaction vessel 101 of such composition, pulse corona discharge will be generated near [the] the wall surface, and exhaust gas will be plasma-ized. If it does so, the following chemical reaction will occur in the plasma-ized exhaust gas.
$2O_2 \rightarrow O_3 +$ The O_2 molecule contained in exhaust gas becoming O_3 by plasma, and O_3 oxidizing further NO which is a detrimental constituent, and making the $1/2O_2NO+O_3 \rightarrow NO_2+O_2$ above-mentioned chemical equation into NO_2 is shown. sticking to NO_2 generated here with the reduction and adsorbent by alkali cleaning -- easy -- removal -- or detoxicating treatment can be carried out. Therefore, the combustor efficiency improvement of the various device accompanied by deodorization or combustion as an electric field device for gas oxidation whose capability do not require a big place, but it is small, and is large even if it becomes a three-dimensional structure, since the corona discharge pole 113,114 can be established in the tubular passage wall 102,103,104,105, Or it is being applied to the flue gas treatment apparatus etc. from which NO_x in the exhaust gas discharged from the device accompanied by various combustion and SO_x are removed.
[0004]
[Problem(s) to be Solved by the Invention]However, with the conventional device, there were the following faults and there was a problem that utilization was very difficult.

(1) Since it is the structure where only space exists between electrodes, arc discharge occurs, and plasma becomes uneven and it may stop inter-electrode insulating strength's falling extremely, when the case where there is much moisture in gas, and the tubular passage wall 102,103,104,105 have waterdrop, for example, and being able to process. Therefore, it is easy to be influenced by the descriptions (moisture, oil, etc.) of processed gas.
(2) Although the conductive film of tungsten etc. is used for the tubular passage wall 102,103,104,105 of a honeycomb structured body as a discharge electrode, costs, such as the membrane formation, electric supply, etc., are dramatically high.
(3) Although Ceramics Sub-Division of a honeycomb structured body is used as a dielectric, a maintenance on the structure is difficult, and since they must all be exchanged if a part of honeycomb structured body should be damaged, a maintenance cost is dramatically high.
[0005]This invention aims at offer of the electric field device for gas oxidation which generates the uniform plasma which haves to carry out no exchange even if some dielectrics are damaged without laminating the line used as the conventional ******** in view of an above-mentioned problem.
[0006]
[Means for Solving the Problem]The 1st electrode in which composition of this invention which attains the above-mentioned purpose has two or more steps of ledged projections up and down toward an inside from right and left sidewalls of a (1) rectangular-pipe-like outer frame, A 1st ctenidium-like electrode which has a ledged projection of the 1st electrode of the above, and two or more steps of ledged projections corresponding to both sides from a septum which divides an inside of the above-mentioned outer frame into right-and-left plurality, A 2nd ctenidium-like electrode which is in a position which shifted from a ledged projection of the 1st electrode of the above, and each 1st ctenidium-like electrode to both sides of a flat wall alternately, and has two or more steps of ledged projections, It has a dielectric which contacts each ledged projection with the 1st electrode of the above, and a 2nd ctenidium-like electrode, is located between them, and contacts each ledged projection with the above-mentioned 1st ctenidium-like electrode and a 2nd ctenidium-like electrode, and is located between them, it is characterized by impressing different polar voltage between the 1st electrode of the above and a 1st ctenidium-like electrode, and a 2nd ctenidium-like electrode -- (2) -- with the 1st electrode that has two or more radiate projections toward an internal center from an inner circle wall of a cylindrical outer frame. The 1st cylindrical dielectric in which a peripheral wall contacts an inside of a tip of a radiate projection of this 1st electrode, Take equally circle distance during a radiate projection with which it is inside this 1st dielectric, and it is cylindrical and has a radiate projection in both a peripheral wall and an inner circle wall and which the peripheral-wall side adjoins, and. One step or two or more steps of 2nd electrode that takes equally circle distance during a radiate projection with which a radiate projection by the side of the above-mentioned peripheral wall and a radiate projection of an electrode of the outside are made into physical relationship alternately shifted, and which the inner circle wall side adjoins and to which a radiate projection tip of the above-mentioned peripheral wall contacts an inner circle wall of a cylindrical dielectric further, The 2nd cylindrical dielectric in which a peripheral wall contacts a radiate projection of an inner circle wall of this 2nd electrode, It has the 3rd electrode that keeps circle distance of a radiate projection which a tip of a radiate projection contacts an inner circle wall of the 2nd dielectric of the above, puts together all end faces of this radiate projection, and adjoins each other from physical relationship which moreover shifted alternately this radiate projection and a radiate projection of an inner circle wall of the 2nd electrode of the above equally, It was made to impress different polarity to an electrode which adjoins each other on both sides of the above-mentioned dielectric.
[0007]
[Function]Since the rear surface of the dielectric is equipped with the ledged projection and radiate projection which carried out the position gap, surface creepage is generated at the rear-face side of the dielectric surface where a projection contacts, and. Since it has a projection and a wall and the voltage of a surface creepage generating side and like-pole nature is impressed so that this surface creepage generating side may be surrounded, the inside of a gas passageway will be in a glow-discharge-plasma state. Namely, in order to generate polar voltage which is different on both sides of a dielectric and to make glow discharge plasma induce by the surface creepage of a dielectric surface, Firing potential is governed by the thickness and inter electrode distance of a dielectric, and

inter-electrode cannot be easily influenced by the description of processed gas, and removal of a dielectric becomes easy, and maintenance is easy. And not a film but manufacture is easy for an electrode, and it is substantially low-cost.

[0008]

[Example]Here, working example of this invention is described with reference to drawing 1 - drawing 3. As for the outline view of the electric field device of the 1st working example, and drawing 2, the front view of electrode structure and drawing 3 of drawing 1 are the sectional side elevations of electrode structure. Two or more ledged projections 1a of the stage are formed in the both sides wall 1d of the outer frame 1 which is an rectangular pipe-like object up and down over the inside. It has the septum 1b in the right-and-left center section by the outer frame 1 and one, and the ledged projection 1a of the above-mentioned side attachment wall 1d and two or more steps of ledged projections 1c corresponding to both sides of this septum 1b are formed. And this outer frame 1 and the ledged projection 1a constitute the 1st electrode, and the septum 1b and the ledged projection 1c constitute a 1st ctenidium-like electrode, for example, it is formed by conductors, such as aluminum and stainless steel. On the other hand, between the 1st electrode and a 1st ctenidium-like electrode, it has a 2nd ctenidium-like electrode. This 2nd ctenidium-like electrode consists of the ledged projection 3a formed in the side attachment wall 1d, the septum 1b, the parallel flat wall 3b, and this flat wall 3b of the outer frame 1 two or more steps up and down, and this ledged projection 3a is formed so that it may become the position which shifted from the vertical position of the ledged projections 1d and 1c. And so that the ledged projections 1d and 3a of the both sides of the 1st electrode and a 2nd ctenidium-like electrode may be contacted at each, being arranged so that the dielectric 2 which consists of insulating materials, such as glass and Ceramics Sub-Division, may serve as a partition -- the ledged projections 1c and 3a of the both sides of a 1st ctenidium-like electrode and a 2nd ctenidium-like electrode -- the same dielectric 2 is arranged so that it may contact, respectively. It is the up-and-down inside of the outer frame 1, and the insulator 4 which is a spacer which fixes a 2nd ctenidium-like electrode up and down, and fixes the dielectric 2 up and down is arranged, for example, it consists of insulating materials, such as Ceramics Sub-Division and glass. Alternation voltage, such as a sine wave with a voltage of several kilovolts - tens of kV and a pulse wave, is impressed between the 1st electrode, a 1st ctenidium-like electrode, and a 2nd ctenidium-like electrode, for example by a frequency number (10 Hz - tens of kHz), and the power supply 5 supplies the electric power for plasma generations.

[0009]Now, introducing the exhaust gas of for example, a gas **** boiler into the inside of the 1st electrode and a 1st ctenidium-like electrode. If the electric power for plasma generations is supplied from the power supply 5 between the 1st electrode, a 1st ctenidium-like electrode, and a 2nd ctenidium-like electrode, inside the space between those electrodes and dielectrics 2, i.e., a tubular passage, glow-discharge-plasma G like the striped pattern shown in drawing 2 (b) will occur. Discharge is induction **** to the whole gas of the space in the tubular passage which this plasma starts discharge near the contact surface of the tip of the ledged projections 1a, 1c, and 3a of the 1st electrode, a 1st ctenidium-like electrode, and a 2nd ctenidium-like electrode, and the dielectric 2, and uses these electrodes and the dielectric 2 as a wall.

[0010]Therefore, the gas by which internal introduction of the 1st electrode and the 1st ctenidium-like electrode was carried out will be in the almost uniform plasma state by the inside, and gas molecules, such as NO_x in exhaust gas, N_2, and O_2, are made to excite and dissociate, and will be in an activity state chemically. As a result, the reaction described below is triggered.

$2O_2 \rightarrow O_3+$ The reaction formula of the $1/2O_2 NO+O_3 \rightarrow NO_2+O_2$ above shows that oxidation treatment of the NO which is the main ingredients of NO_x introduced into the 1st electrode and a 1st ctenidium-like electrode is carried out to NO_2. Usually, when performing flue gas treatment of a gas **** boiler, it is NO_x which is the target of exhaust gas purifying treatment, but the main ingredients are NO. Although the processing is deficiently difficult for NO to reactivity, if it oxidizes to NO_2 as mentioned above, detoxicating treatment can be easily carried out by the method of carrying out adsorbent with the reduction and adsorbent by alkali cleaning, etc. Since it is shifted and allocated so that a dielectric may be installed in inter-electrode [polar / different] and the electrode of different

polarity may not adjoin each other on both sides of a dielectric, discharge starting is carried out from a dielectric surface, and there are also few electric field concentrates inside a dielectric. Therefore, since it is always insulated with the dielectric between discharge electrodes, if influenced by the moisture in gas, oil, etc., the plasma state stable [that there is nothing] is maintainable.
Furthermore, as for four fields of a tubular passage wall, one field has a dielectric and the structure where the third page of ** is surrounded by the conductor of same electric potential.
There is an operation which carries out flattening of the field strength distribution, and makes plasma uniform.
Since a throughput can be increased by connecting many electric field devices of this example to parallel, or extending a ledged projection and a dielectric to a lengthwise direction, and increasing the number of tubular passages, large-scale-izing is also easy. And the form which inserts a dielectric in the inside of a metal ctenidium-like electrode is simple for electrode structure, and the maintenance of a dielectric is easy for it, and it is low. [of a manufacturing cost]
[0011]Drawing 4, drawing 5, and drawing 6 explain the 2nd working example concerning this invention. Drawing 4 is a figure showing the electric field device of the 2nd working example. The figure and drawing 6 which drawing 5 shows an opening section with the front view of electrode structure show the side section of electrode structure. The 1st electrode has the structure where two or more radiate projections 11a project by hoop direction regular intervals inside the cylindrical outer wall 11b. The 1st dielectric 21 makes cylindrical shape, has also become a septum, and the tip of the radiate projection 11a of the 1st electrode touches the outside. On the outside of the cylindrical septum 12b, the radiate projection 12a has projected two or more 2nd electrode by hoop direction regular intervals, and the radiate projection 12c has projected it by hoop direction regular intervals also inside the septum 12b. [two or more] These radiate projections 12c of two or more touch the outside of the 2nd dielectric 22 of that inside. In the radiate projection 12c projected to the radiate projection 12a projected on the outside of the septum 12b, and its inside, as for the distance from each adjacent projection 12a, for example, a certain projection, to the next projection 12a, the circle distance from those tips to a tip is equal. Therefore, the number of the projections 12c has become less than the number of the projections 12a in the outside and the inside of the septum 12b. The 2nd dielectric 22 makes cylindrical shape, has also become a septum, and two or more radiate projections 12c of the 2nd electrode touch the outside.
Inside a septum, the projection 13a of the plurality of the 3rd electrode touches.
The 3rd electrode joins two or more radiate projections 13a at one end, and it touches inside the 2nd dielectric 22, the end, i.e., the tip, of another side.
The interval at the tips those projections 13a is arranged so that those circle distance may become equal.
It shifts and the projection (for example, 11a, and 12a, 12c and 13a) which sandwiches the 1st dielectric 21 and 2nd dielectric 22 is arranged by carrying out so that each may not adjoin each other. The circle distance at adjacent monotonous tips is almost fixed, and the wire extension of each radiate projection of arrangement of each radiate projection is also constant. In this way, many flabellate opening sections are formed like drawing 5. The 1st, 2nd, and 3rd electrodes are formed with metallic materials (conductor), such as aluminum and stainless steel, and the 1st and 2nd dielectrics (21 and 22) are formed by insulating materials, such as glass and Ceramics Sub-Division. 5 is a power supply, the 1st electrode and 3rd electrode are connected to the terminal of one of these, and the 2nd electrode is connected to the terminal of another side.
[0012]If electric power is supplied to the above-mentioned electrode from the power supply 5, introducing the exhaust gas of for example, a gas **** boiler into the inside of this cylindrical electrode, glow discharge plasma will occur inside the tubular passage which carried out the flabellate section, and the reaction described below as a result will be triggered.
$2O_2 \rightarrow O_3+$ The reaction formula of the $1/2O_2NO+O_3 \rightarrow NO_2+O_2$ above shows that oxidation treatment of the NO which is the main ingredients of NO_x introduced into the 1st electrode is carried out to NO_2. Although the 2nd working example replaces the plate-like dielectric of said 1st working example cylindrical, the 1st and 2nd working example is common, and, as for the principle of a plasma

generation, the performance of NO_x oxidation treatment is equivalent. Although this example explained NO_x oxidation treatment, it is applicable to O_3 generation, oxidation treatment to CO_2 of CO, etc. The 1st and 2nd working example can be further formed in multistage.

[0013]

[Effect of the Invention]As explained above, according to this invention, a gaseous oxidation treatment apparatus is realizable by the compact and low cost. And a maintenance is easy, and since large-scale-izing is also easy, value industrial as electric field devices for gas oxidation, such as a device which oxidize O_2, oxidize the device and NO_x which manufacture O_3 and make deodorization and a combustor efficiency improvement, SO_x, CO, etc., and performs flue gas treatment, such as denitrification and desulfurization, is remarkably high.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The perspective view of the 1st working example of this invention.
[Drawing 2]The front view of the 1st working example.
[Drawing 3]The III-III sectional view of drawing 2.
[Drawing 4]The perspective view of the 2nd working example.
[Drawing 5]The front view of the 2nd working example.
[Drawing 6]The VI-VI sectional view of drawing 5.
[Drawing 7]The perspective view of a conventional example.
[Drawing 8]The development view of drawing 7.
[Description of Notations]
a, and 1c and 3a Ledged projection
1b Septum
1 d Side attachment wall
2 Dielectric
3b Flat wall
5 Power supply
11a, 12a, 12c, and 13a Radiate projection
11b Outer wall
12b Septum
21 and 22 Dielectric

[Translation done.]

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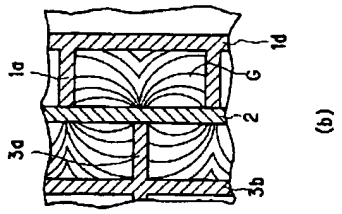
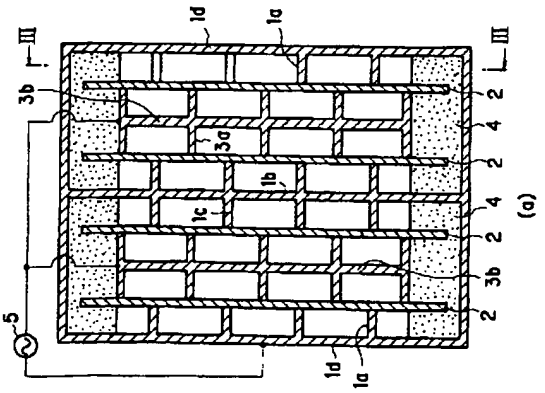
(54)【発明の名称】　気体酸化用電界装置

(57)【要約】

【目的】　処理ガスの性状によらず均一のプラズマを発生させる気体酸化用電界装置を提供する。

【構成】　同一形状の電極の突起１ａと３ａ，１ｃと３ａを例えば誘電体２の右側と左側で互いに隣り合わないようにずらして配設することにより、誘電体２と突起１ａ，１ｃ，３ａが接触している面の反対側の面すなわち、電極が接触していない誘電体表面において沿面放電を発生させる。同時に、上記沿面放電発生面に対して電極１ａ，１ｄ，１ｂ，１ｃ，３ａ，３ｂが配設されていて、その沿面放電発生面と同極性の電圧が印加されることから、沿面放電発生面とそれをとり囲むように設置された電極との間の空間すなわち、管状のガス通路内部はグロー放電プラズマ状態となる。





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【特許請求の範囲】

【請求項１】　角筒状の外枠の左右側壁より内部に向って上下に複数段の棚状突起を有する第１電極と、

上記外枠の内部を左右複数個に仕切る隔壁より左右両側に上記第１電極の棚状突起と対応する複数段の棚状突起を有する第１櫛歯状電極と、

平壁の左右両側に上記第１電極及び第１櫛歯状電極それぞれの棚状突起と互い違いにずれた位置にあって複数段の棚状突起を有する第２櫛歯状電極と、

上記第１電極と第２櫛歯状電極とのそれぞれの棚状突起に接触してその間に位置し及び上記第１櫛歯状電極と第２櫛歯状電極とのそれぞれの棚状突起に接触してその間に位置する誘電体とを有し、

上記第１電極及び第１櫛歯状電極と第２櫛歯状電極との間に異なる極性の電圧を印加した気体酸化用電界装置。

【請求項２】　円筒状の外枠の内周壁より内部中心に向って複数個の放射状突起を有する第１電極と、

この第１電極の放射状突起の先端内部に外周壁が接触する円筒状の第１誘電体と、

この第１誘電体の内側にあって円筒状で外周壁及び内周壁双方に放射状突起を有し外周壁側の隣り合う放射状突起間の円弧距離を等しく採ると共に上記外周壁側の放射状突起とその外側の電極の放射状突起とを互い違いにずれた位置関係とし内周壁側の隣り合う放射状突起間の円弧距離を等しく採り更には上記外周壁の放射状突起先端が円筒状誘電体の内周壁と接触する１段又は複数段の第２電極と、

この第２電極の内周壁の放射状突起に外周壁が接触する円筒状の第２誘電体と、

上記第２誘電体の内周壁に放射状突起の先端が接触しこの放射状突起の基端を全てひとまとめにし隣り合う放射状突起の円弧距離を等しくしかもこの放射状突起と上記第２電極の内周壁の放射状突起とを互い違いにずれた位置関係におく第３電極とを有し、

上記誘電体を挟んで隣り合う電極には異なった極性を印加するようにした気体酸化用電極。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明はO_2を酸化してO_3を製造し、脱臭や燃焼効率改善を行う装置、またはNO_xやSO_xを酸化して脱硝・脱硫を行う排ガス処理装置などに適用される気体酸化用電界装置に関する。

【０００２】

【従来の技術】図７及び図８は従来から用いられている気体酸化用電界装置の説明図である。この装置により例えばガス焚きボイラの排ガス中のNO_xを処理する場合を例にとり説明する。図７において１０１は従来の気体酸化用電界装置の反応容器であり、正方形の断面を有する通路が飛行に隣りあって配設されており、アルミナ磁器，窒化珪素磁器，ジルコニア磁器など絶縁性のセラミ

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ックスからなるハニカム構造体を形成する。このハニカム構造体の一つの管状通路について説明すると、これは１０２，１０３，１０４，１０５の四つの連続した内壁により構成され、展開すれば図８のようになる。また内壁１０２，１０３，１０４，１０５は境界線１０６，１０７，１０８，１０９によって９０°に折り曲げられた構造をなす。内壁１０２の一端１１０に電源１２７に連なる端子１１１，１１２と続いてタングステンなどの導電膜からなるコロナ放電極１１３，１１４が互いに等間隔かつ平行に内壁１０２，１０３，１０４，１０５の表面に連続して設置されている。

【０００３】このような構成の反応容器１０１の内部にガス焚きボイラの排ガスを導入しつつ上記コロナ放電極１１３と１１４の間にパルス巾が１ns～１０００ns程度のパルス高電圧を印加するとその内壁表面近傍にはパルスコロナ放電を発生して排ガスをプラズマ化する。そうするとプラズマ化された排ガス中では下記化学反応が起こる。

$$2O_2 \rightarrow O_3 + 1/2O_2$$

$$NO + O_3 \rightarrow NO_2 + O_2$$

上記化学反応式は排ガス中に含まれるO_2分子がプラズマによりO_3になり、さらにO_3が有害成分であるNOを酸化させてNO_2にすることを示す。ここで生成されたNO_2はアルカリ洗浄による還元や吸着剤で吸着することにより容易に除去または無害化処理することができる。したがって、コロナ放電極１１３，１１４を管状通路内壁１０２，１０３，１０４，１０５に設けることができるので立体的な構造となっても大きな場所を要せず小型で能力の大きい気体酸化用電界装置として脱臭や燃焼を伴う各種装置の燃焼効率改善、または各種燃焼を伴う装置から排出される排ガス中のNO_xやSO_xを除去する排ガス処理装置等に適用されつつある。

【０００４】

【発明が解決しようとする課題】しかしながら、従来の装置では下記のような欠点があり、実用化が非常に困難であるという問題点があった。

（１）電極と電極の間には空間のみ存在する構造なので、例えばガス中の水分が多い場合や管状通路内壁１０２，１０３，１０４，１０５に水滴がある場合には電極間の絶縁強度が極端に低下し、アーク放電が発生してプラズマが不均一となり処理できなくなることがある。したがって被処理ガスの性状（水分，油分など）の影響を受けやすい。

（２）ハニカム構造体の管状通路内壁１０２，１０３，１０４，１０５には放電電極としてタングステンなどの導電性の膜が使用されているが、その成膜や給電などのコストが非常に高い。

（３）誘電体としてハニカム構造体のセラミックスを使用しているが、その構造上メンテナンスが困難であり、万一ハニカム構造体の一部が破損した場合にはそれを全

部交換しなければならないので、保守コストが非常に高い。

【０００５】本発明は、上述の問題に鑑み、従来の如き電極となるラインを被着することなく誘電体の一部が破損しても全部の交換をする必要がない均一のプラズマを発生する気体酸化用電界装置の提供を目的とする。

【０００６】

【課題を解決するための手段】上述の目的を達成する本発明の構成は、（１）角筒状の外枠の左右側壁より内部に向って上下に複数段の棚状突起を有する第１電極と、上記外枠の内部を左右複数個に仕切る隔壁より左右両側に上記第１電極の棚状突起と対応する複数段の棚状突起を有する第１櫛歯状電極と、平壁の左右両側に上記第１電極及び第１櫛歯状電極それぞれの棚状突起と互い違いにずれた位置にあって複数段の棚状突起を有する第２櫛歯状電極と、上記第１電極と第２櫛歯状電極とのそれぞれの棚状突起に接触してその間に位置し及び上記第１櫛歯状電極と第２櫛歯状電極とのそれぞれの棚状突起に接触してその間に位置する誘電体とを有し、上記第１電極及び第１櫛歯状電極と第２櫛歯状電極との間に異なる極性の電圧を印加したことを特徴とし、また、（２）円筒状の外枠の内周壁より内部中心に向って複数個の放射状突起を有する第１電極と、この第１電極の放射状突起の先端内部に外周壁が接触する円筒状の第１誘電体と、この第１誘電体の内側にあって円筒状で外周壁及び内周壁双方に放射状突起を有し外周壁側の隣り合う放射状突起間の円弧距離を等しく採ると共に上記外周壁側の放射状突起とその外側の電極の放射状突起とを互い違いにずれた位置関係とし内周壁側の隣り合う放射状突起間の円弧距離を等しく採り更には上記外周壁の放射状突起先端が円筒状誘電体の内周壁と接触する１段又は複数段の第２電極と、この第２電極の内周壁の放射状突起に外周壁が接触する円筒状の第２誘電体と、上記第２誘電体の内周壁に放射状突起の先端が接触しこの放射状突起の基端を全てひとまとめにし隣り合う放射状突起の円弧距離を等しくしかもこの放射状突起と上記第２電極の内周壁の放射状突起とを互い違いにずれた位置関係におく第３電極とを有し、上記誘電体を挟んで隣り合う電極には異なった極性を印加するようにしたことを特徴とする。

【０００７】

【作用】誘電体の表裏に位置ずれした棚状突起や放射状突起を備えているため、突起が接触する誘電体表面のその裏面側において沿面放電が発生されると共に、この沿面放電発生面をとり囲むように突起や壁が備えられて沿面放電発生面と同極性の電圧が印加されるため、ガス通路内部はグロー放電プラズマ状態となる。すなわち、誘電体の両側に異なる極性の電圧を発生させ誘電体表面の沿面放電によりグロー放電プラズマを誘発させるため、放電開始電圧は誘電体の厚さや電極間距離に支配され、電極間は被処理ガスの性状の影響を受けにくく、また誘

電体の取り外しが容易となってメインテナンスが簡単である。しかも電極は膜でなく製造が容易でコストが大幅に低い。

【０００８】

【実施例】ここで、本発明の実施例を図１～図３を参照して説明する。図１は第１実施例の電界装置の外観図、図２は電極構造の正面図、図３は電極構造の側断面図である。角筒状体である外枠１の左右両側壁１ｄにはその内部に上下にわたり複数段の棚状突起１ａが設けられている。更に、外枠１と一体で左右中央部に隔壁１ｂを有し、この隔壁１ｂの左右両側に上記側壁１ｄの棚状突起１ａと対応する複数段の棚状突起１ｃが設けられている。そして、この外枠１及び棚状突起１ａが第１電極を構成し、隔壁１ｂと棚状突起１ｃが第１櫛歯状電極を構成して、例えばアルミニウムやステンレス鋼等の導体で形成される。他方、第１電極と第１櫛歯状電極との間には、第２櫛歯状電極が備えられる。この第２櫛歯状電極は外枠１の側壁１ｄや隔壁１ｂと平行な平壁３ｂとこの平壁３ｂに上下に複数段形成された棚状突起３ａとからなり、この棚状突起３ａは、棚状突起１ｄ，１ｃの上下位置とずれた位置となるように形成されている。そして、第１電極と第２櫛歯状電極との双方の棚状突起１ｄ，３ａにそれぞれに接触するように、例えばガラスやセラミックスなどの絶縁材料からなる誘電体２が仕切りとなるよう配置され、また第１櫛歯状電極と第２櫛歯状電極との双方の棚状突起１ｃ，３ａそれぞれ接触するように同様の誘電体２が配置されている。外枠１の上下内側であって、第２櫛歯状電極を上下に固定しかつ誘電体２を上下に固定するスペーサである絶縁体４が配置され例えばセラミックスやガラスなどの絶縁材料からなる。電源５は、例えば周波数数十Hz～数十KHz で電圧数KV～数十KVの正弦波やパルス波などの交番電圧が第１電極、第１櫛歯状電極と第２櫛歯状電極との間に印加され、プラズマ発生用の電力を供給する。

【０００９】さて、第１電極及び第１櫛歯状電極の内部に例えばガス焚きボイラの排ガスを導入しつつ、第１電極、第１櫛歯状電極と第２櫛歯状電極との間に電源５からプラズマ発生用の電力を供給すると、それらの電極と誘電体２との間の空間すなわち管状通路内部には図２（ｂ）に示す縞模様のようなグロー放電プラズマＧが発生する。このプラズマは第１電極や第１櫛歯状電極と第２櫛歯状電極の棚状突起１ａ，１ｃ，３ａの先端と誘電体２との接触面近傍から放電を開始し、これら電極と誘電体２とを内壁とする管状通路内の空間のガス全体に放電が誘発さる。

【００１０】したがって、第１電極、第１櫛歯状電極の内部導入されたガスは、その内部でほぼ均一なプラズマ状態となり、排ガス中のNO_x，N_2，及びO_2などのガス分子は励起及び解離させられて化学的に活性な状態となる。その結果、以下に述べる反応がひき起こされ

る。

$2O_2 \rightarrow O_3 + 1/2O_2$

$NO+O_3 \rightarrow NO_2+O_2$

上記の反応式は第１電極、第１櫛歯状電極に導入されたNO_xの主成分であるNOがNO_2に酸化処理されることを示す。通常、ガス焚きボイラの排ガス処理を行う場合、排ガス浄化処理の対象となるものはNO_xであるが、その主成分はNOである。NOは反応性に乏しくその処理が難しいが、上述のようにNO_2に酸化するとアルカリ洗浄による還元や吸着剤により吸着剤する方法などにより容易に無害化処理できる。また、誘電体を極性の異なる電極間に設置し、その異なる極性の電極が誘電体をはさんで隣り合わないようにずらして配設されるので、誘電体表面から放電開始し、誘電体内部での電界集中も少い。したがって放電電極間は誘電体により常に絶縁されているので、ガス中の水分や油分などの影響を受けるとなく安定したプラズマ状態を維持することができる。さらに管状通路内壁の四つの面は、一つの面が誘電体、たの三面が同電位の導体で囲まれる構造となっており、電界強度分布を平坦化してプラズマを均一にする作用がある。また、本実施例の電界装置を多数並列に接続したり、あるいは、棚状突起及び誘電体を縦方向に延長して管状通路の数を増やすことにより処理量を増大させることができるので大容量化も容易である。しかも電極構造は金属製の櫛歯状電極の内部に誘電体を差込む形式の簡単なものであり、誘電体のメンテナンスが容易であり、製造コストも低い。

【００１１】本発明に係る第２実施例を図４，図５及び図６により説明する。図４は第２実施例の電界装置を示す図である。図５は電極構造の正面図で開口断面を示す図、図６は電極構造の側断面を示すものである。第１の電極は、円筒状の外壁１１ｂの内側に周方向等間隔で放射状突起１１ａが複数突出する構造を有する。第１の誘電体２１は、円筒状をなし、隔壁にもなっていて、その外側には第１の電極の放射状突起１１ａの先端が接触している。第２の電極は、円筒状の隔壁１２ｂの外側には周方向等間隔で放射状突起１２ａが複数突出していて、また隔壁１２ｂの内側にも周方向等間隔で放射状突起１２ｃが複数突出している。この複数の放射状突起１２ｃはその内側の第２の誘電体２２の外側に接触している。なお、隔壁１２ｂの外側に突出した放射状突起１２ａ及びその内側に突出した放射状突起１２ｃにおいて、それぞれの隣り合う突起、例えばある突起１２ａからその隣りの突起１２ａまでの距離はそれらの先端から先端迄の円弧距離が等しくなっている。そのため、隔壁１２ｂの外側と内側において突起１２ａの数よりも突起１２ｃの数が少なくなっている。第２の誘電体２２は、円筒状をなし、隔壁にもなっていて、その外側には第２の電極の放射状突起１２ｃが複数接触しており、隔壁の内側には第３の電極の複数の突起１３ａが接触している。第３の

電極は、複数の放射状突起１３ａを一方の端部で接合し、他方の端すなわち先端は第２の誘電体２２の内側に接触しており、それらの突起１３ａの先端どうしの間隔はそれらの円弧距離が等しくなるよう配置されている。また、第１の誘電体２１及び第２の誘電体２２をはさむ突起（例えば１１ａと１２ａ，１２ｃと１３ａ）はそれぞれが隣り合わないようずれして配置されている。さらに、各放射状突起の配置は、隣り合う平板の先端どうしの円弧距離がほぼ一定になっているし、各放射状突起の突出長さも一定である。こうして、図５のように多数の扇状の開口断面が形成される。なお、第１，第２，及び第３の電極は、アルミニウムやステンレス鋼などの金属材料（導体）で形成され、第１及び第２の誘電体（２１及び２２）はガラスやセラミックスなどの絶縁材料で形成される。５は電源であり、その一方の端子には第１の電極及び第３の電極が接続され、他方の端子には第２の電極が接続されている。

【００１２】この円筒状の電極内部に例えばガス焚きボイラの排ガスを導入しつつ、電源５から上記電極に電力を供給すると、扇状の断面をした管状通路内部にはグロー放電プラズマが発生し、その結果以下に述べる反応がひき起こされる。

$2O_2 \rightarrow O_3 + 1/2O_2$

$NO+O_3 \rightarrow NO_2+O_2$

上記の反応式は第１の電極に導入されたNO_xの主成分であるNOがNO_2に酸化処理されることを示す。なお、第２実施例は前記第１実施例の平板状の誘電体を円筒状に置き換えたものであるが、プラズマ発生の原理は第１及び第２実施例ともに共通しており、NO_x酸化処理の性能は同等である。本実施例ではNO_x酸化処理について説明したが、O_3生成やCOのCO_2への酸化処理等にも適用可能である。なお、第１，第２実施例共、さらに多段に形成できる。

【００１３】

【発明の効果】以上説明したように本発明によれば、コンパクトかつ低コストで気体の酸化処理装置を実現することができる。しかもメンテナンスが簡単で大容量化も容易であるので、O_2を酸化してO_3を製造し脱臭や燃焼効率改善を行う装置やNO_x，SO_x，COなどを酸化して脱硝・脱硫等の排ガス処理を行う装置などの気体酸化用電界装置として産業上の価値が著しく高い。

【図面の簡単な説明】

【図１】本発明の第１実施例の斜視図。

【図２】第１実施例の正面図。

【図３】図２のIII-III 断面図。

【図４】第２実施例の斜視図。

【図５】第２実施例の正面図。

【図６】図５のVI－VI断面図。

【図７】従来例の斜視図。

【図８】図７の展開図。

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【符号の説明】

a，1c，3a　棚状突起
1b　隔壁
1d　側壁
2　誘電体
3b　平壁

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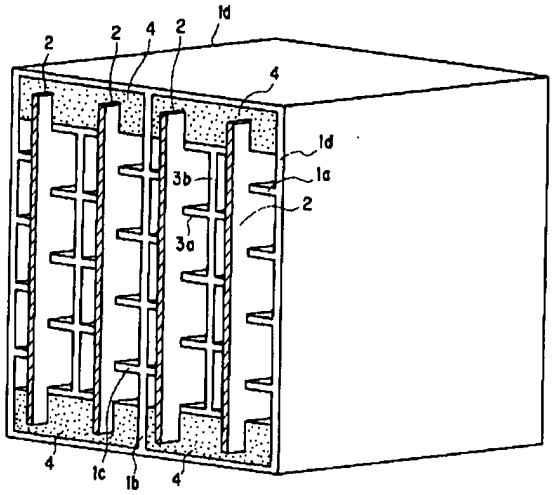
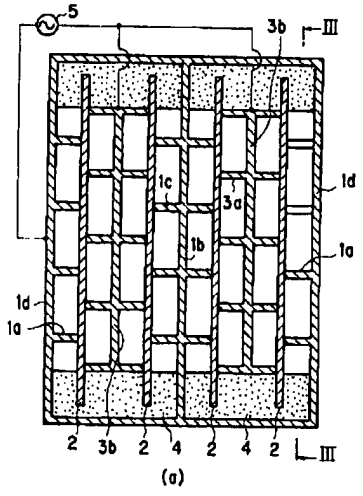
＊5　電源
11a，12a，12c，13a　放射状突起
11b　外壁
12b　隔壁
21，22　誘電体

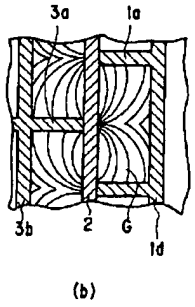
＊

【図1】

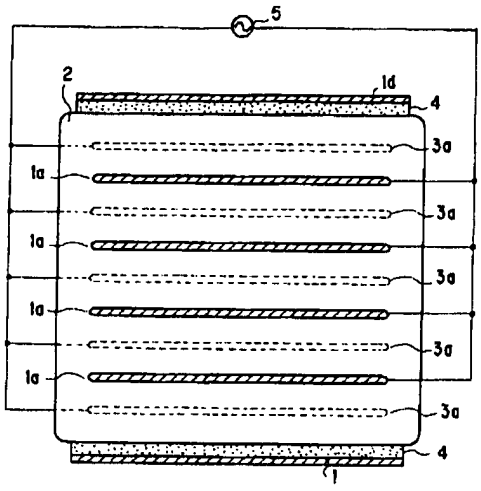


【図2】





【図3】



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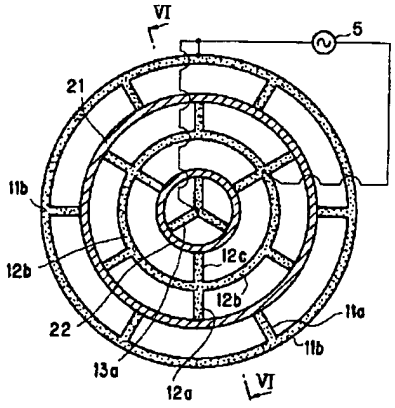

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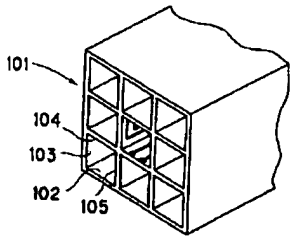

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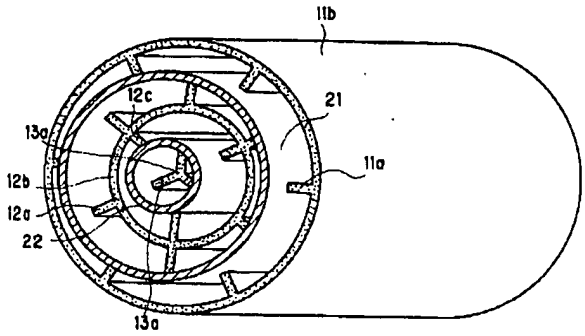

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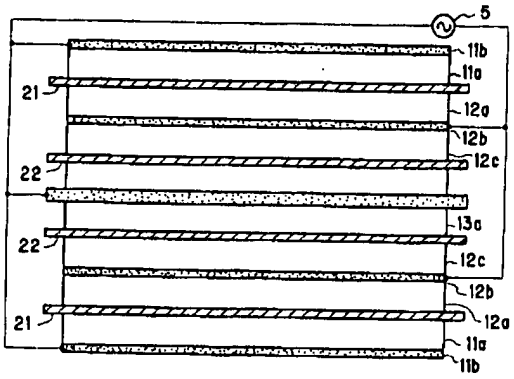

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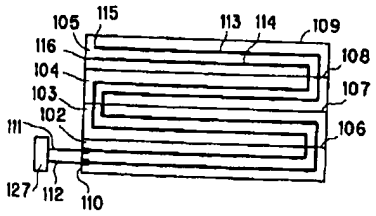

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